Contribution to the knowledge of *Pentaleyrodes* Takahashi (Hemiptera: Aleyrodidae) from China

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Abstract: Four species in the genus *Pentaleyrodes* Takahashi (Hemiptera: Aleyrodidae) from China, *P. yasumatsui* Takahashi, *P. hongkongensis* Takahashi, *P. cinnamomi* (Takahashi) and *P. linderae* Chou & Yan are reported in this paper. *P. yasumatsui*, a newly recorded species to China, and *P. hongkongensis*, a newly recorded species to the Chinese Mainland are redescribed, and the identification of *P. cinnamomi* and *P. linderae* is discussed. Morphological illustrations and photographs from a scanning electron microscope (SEM) of these four species are provided. An identification key to these *Pentaleyrodes* species is given.

Key words: whiteflies; taxonomy; new record; key

中国指粉虱属 *Pentaleyrodes* Takahashi 种类研究（半翅目：粉虱科）

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摘要：对中国粉虱科指粉虱属 *Pentaleyrodes* 4 种指粉虱，安松氏指粉虱 *P. yasumatsui* Takahashi, 香港指粉虱 *P. hongkongensis* Takahashi, 樟指粉虱 *P. cinnamomi* (Takahashi) 和钓樟指粉虱 *P. linderae* Chou & Yan 进行了分类研究。描记了中国新纪录种安松氏指粉虱 *P. yasumatsui* 和中国大陆新纪录种香港指粉虱 *P. hongkongensis*, 并对樟指粉虱 *P. cinnamomi* 和钓樟指粉虱 *P. linderae* 的鉴别特征进行了讨论。同时提供了 4 种指粉虱玻片标本形态特征图和环境扫描电镜特征图。以伪蛹特征编制了指粉虱属所有种类的分类检索表。

关键词：粉虱；分类；新纪录；检索表

Introduction

The genus *Pentaleyrodes* (Hemiptera: Aleyrodidae) was originally established by Takahashi (1937) with *P. cinnamomi* as its type species by monotypy. Only four known species hitherto have been placed in this genus, namely, *P. cinnamomi* Takahashi, *P. hongkongensis* Takahashi, *P. linderae* Chou & Yan, and *P. yasumatsui* Takahashi (Martin & Mound, 2007). All the species of *Pentaleyrodes* are distributed in East Asian countries with

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three distributed in China: *P. cinnamomi* from China (Taiwan) (Takahashi 1932, 1937), *P. hongkongensis* from China (Hong Kong) (Takahashi 1941) and *P. linderae* from China (Hunan) (Chou and Yan 1988). *P. yasumatsui* is recorded from Japan and Korea (Takahashi 1939; Suh 2009; Martin & Mound 2007). Also all of the described species of *Pentaleyrodes* hitherto are only known from plants in the family Lauraceae. During our study of *Pentaleyrodes*, *P. yasumatsui* is recognized as a new recorded species to China and *P. hongkongensis* is recognized as a newly recorded species to the Chinese Mainland. In addition, we added details on the other two species in this genus to provide complete information of all four species in this genus.

Material and methods

Specimens of *Pentaleyrodes yasumatsui* Takahashi and *Pentaleyrodes hongkongensis* Takahashi were mounted following Martin (1987). The terminology for morphological structures follows Bink-Moenen (1983), Martin (1985) and Gill (1990). The measurements and camera lucida drawings were made using the OLYMPUS microscope BX63. A sample of the specimen was prepared for SEM studies by cutting the leaf along with a puparium, then mounting it on a stub on black carbon conductive adhesive (Wang *et al*. 2013, 2014). The Scanning electron microscope images were taken using a Philips XL30-Environmental Scanning Electron Microscope at 20 kV/EHT and 80 Pa from 160 × to 1271 × magnification. Specimens are deposited in the Insect Collection of Yangzhou University and the Insect Collection of Zhejiang Agriculture & Forestry University, China.

Taxonomy

Pentaleyrodes Takahashi, 1937

Pentaleyrodes Takahashi, 1937. *Kontyû*, 11: 310. Type species. *Pentaleyrodes cinnamomi* (Takahashi), by monotypy.

Diagnosis. Median in size, elliptical in shape. Marginal teeth arranged in 2 rows, submarginal area not separated from dorsal disk, but with 16 pairs of setae arranged in a row, each arising from a small tubercle. Thoracic tracheal folds and pores absent, caudal furrow distinct. Vasiform orifice subcordate, not notched at the hind end. Operculum subcordate, filling more than half of the orifice. Lingula hidden.

1. ***Pentaleyrodes cinnamomi* (Takahashi)** (Fig. 1)

Aleyrodes cinnamomi Takahashi, 1932. *Report. Department of Agriculture. Government Research Institute. Formosa*, 59: 36.

Pentaleyrodes cinnamomi Takahashi, 1937. *Kontyû*, 11: 310.

Distribution. China (Jiangxi, Taiwan).

Host plants. Lauraceae: *Cinnamomum japonicum*, *Machilus* sp., *Phoebe formosana* (Evans, 2008).

Remarks. This species was first described in the genus *Aleyrodes* by Takahashi (1932). The puparium with 3 large black patches on the median area (Fig. 1A) and in some specimens longitudinally black on the median area (Fig. 1B). *P. cinnamomi* was very common on the

trees of the Lauraceae in Taiwan (Takahashi 1937). Lin (1961) had recorded this species, collected on *Cinnamomum camphora* in Jingdezhen National Forest Park, Jiangxi, on 17 April 1958, but he did not identify it as *P. cinnamomi*.

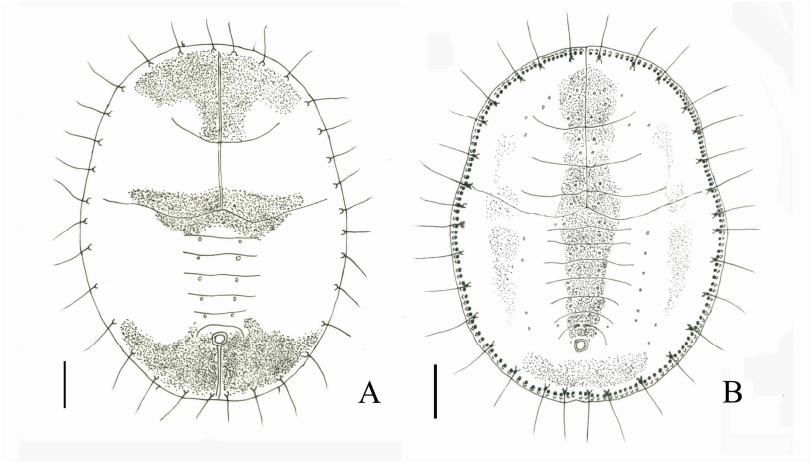


Figure 1. *Pentaleyrodes cinnamomi* (Takahashi). A. Puparium with 3 large black patches at the anterior part, transverse moulting suture and the posterior part (after Takahashi 1937); B. Puparium longitudinally black on the median area (after Lin 1961). Scale bars = 0.2 mm.

2. ***Pentaleyrodes linderae* Chou & Yan** (Fig. 2)

Pentaleyrodes linderae Chou & Yan, 1988. *Entomotaxonomia*, 10: 244.

Distribution. China (Hunan).

Host plants. *Lindera communis*.

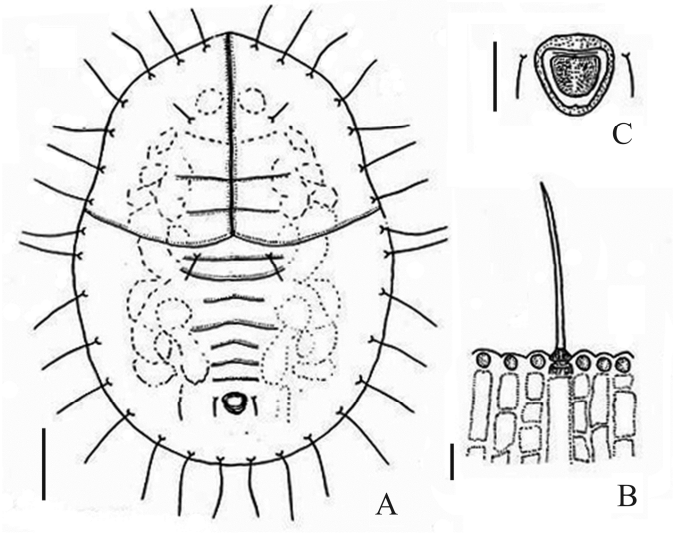


Figure 2. *Pentaleyrodes linderae* Chou & Yan. A. Puparium; B. Margin and submarginal setae; C. Vasiform orifice. Scale bars = 0.2 mm (A); 0.04 mm (B); 0.05 mm (C) (from Chou & Yan 1988).

Remarks. This species resembles *P. hongkongensis*, but differs in the cephalothorax narrower, the presence of cephalic and 1st abdominal setae, and the submarginal setae being longer. It also resembles *P. cinnamomi*, but differs in its smaller pupal case and the small tubercle from which the submarginal setae arises constricted at its mid-point and top (Chou & Yan 1988).

3. ***Pentaleyrodes hongkongensis* Takahashi** (Figs. 3–6), new record to Chinese Mainland

Pentaleyrodes hongkongensis Takahashi, 1941. *Transactions of the Natural History Society of Formosa*, 31: 389.

Diagnosis. Puparia: pale white, elliptical, broadest at the first abdominal segment region; about 0.75–1.1 mm in length, 0.5–0.7 mm in width. Margin surrounded by a waxy palisade and fringe. Margin teeth very small, arranged in 2 rows, the outer teeth rounded or triangular, about 8–10 crenulations in 0.1 mm; the inner teeth rounded. Anterior and posterior marginal setae absent.

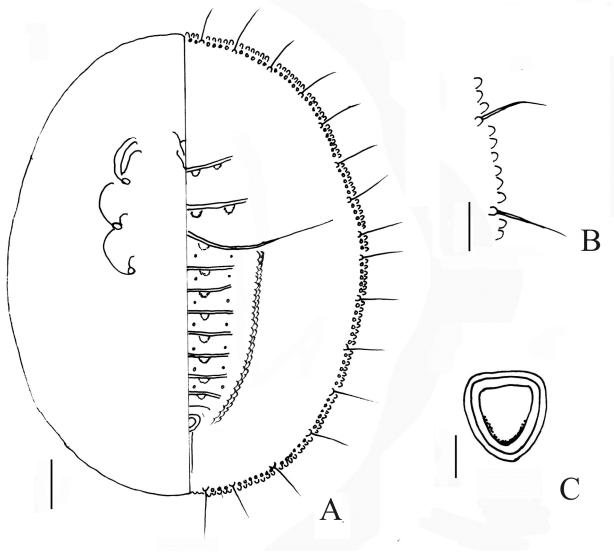


Figure 3. *Pentaleyrodes hongkongensis* Takahashi. A. Puparium; B. Margin and submarginal setae; C. Vasiform orifice. Scale bars = 0.1 mm (A); 0.05 mm (B); 0.02 mm (C).

Dorsum. Submargin area not clear, not separated from the dorsal disk, 16 pairs of setae including caudal setae along the submargin, 7 pairs of which are on the cephalothorax and 9 pairs on the abdomen, all the setae arising from a small tubercle, subequal in length, about 115.3 μm. Many furrow-like markings run mesad from the margin, with large irregular reticulations except on the median area and the narrow marginal area. Longitudinal molting suture reaching the margin but with transverse molting suture not reaching the margin. A longitudinal row of markings are distributed on each side of submedian area, extending from cephalothorax to abdomen. Thoracic and abdominal segment sutures well-defined, abdominal I–VI subequal in length, about 43.6 μm; abdominal VII about 31.2 μm. A pair of depressions present at the median of each thoracic and abdominal segment suture. A few pores distributed in submarginal area. Cephalic and 1st abdominal setae absent, 8th abdominal setae present, about

21.8 μm. Thoracic tracheal folds and pores absent.

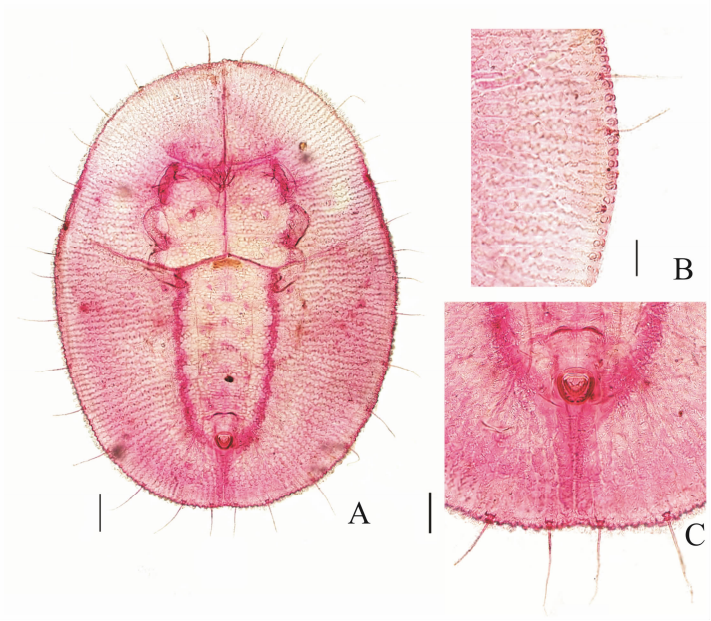


Figure 4. *Pentaleyrodes hongkongensis* Takahashi, slide mounted specimen. A. Puparium; B. Margin and submarginal setae; C. Vasiform orifice and caudal furrow. Scale bars = 0.1 mm (A); 0.05 mm (B); 0.05 mm (C).

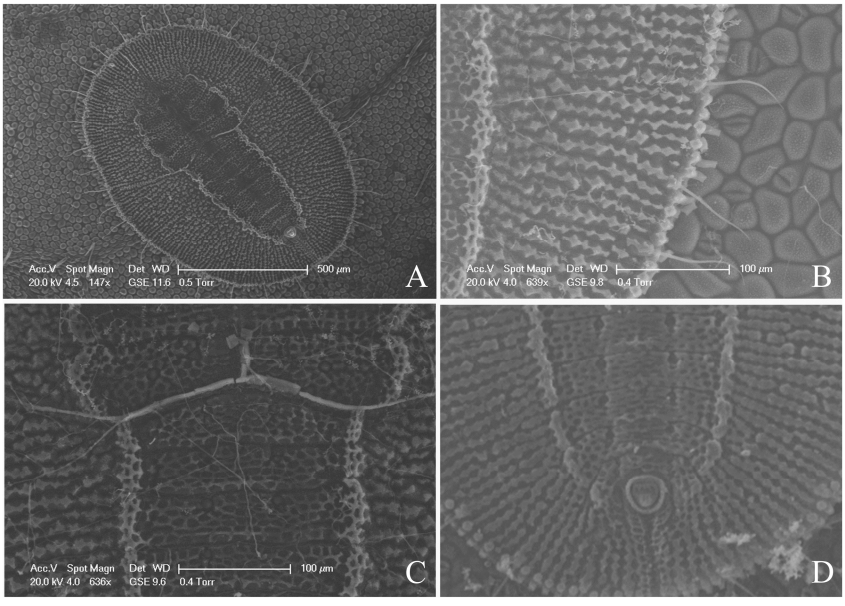
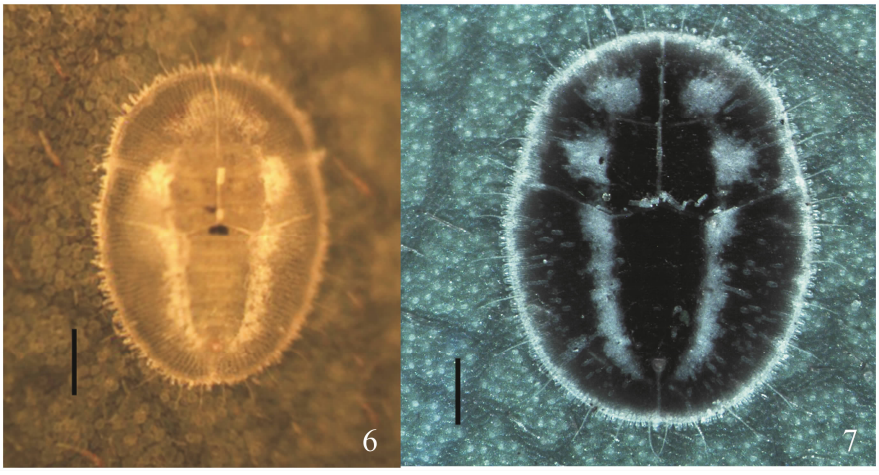


Figure 5. SEM of *Pentaleyrodes hongkongensis* Takahashi. A. Puparium; B. Margin and submarginal setae; C. Moulting suture and abdominal segment; D. Vasiform orifice and caudal furrow.

Vasiform Orifice. Vasiform orifice slightly elevated, cordate, surrounded by a broad ring, 38.6 μm in length, 39.7 μm in width. Operculum subcordate, 29.1 μm long, 31.3 μm wide,

almost covering all the orifice, concealing lingula tip. Caudal furrow faintly discernible, very narrow, about 116 μm long.



Figures 6, 7. Puparium. 6. *Pentaleyrodes hongkongensis* Takahashi; 7. *Pentaleyrodes yasumatsui* Takahashi. Scale bars = 0.2 mm.

Specimens examined. 10 puparia on 10 slides, on *Millettia pachycarpa*, **China,** Damingshan Mt., 10-VIII-2011, Coll. Jirui WANG, deposited in Insect Collection of Zhejiang Agriculture & Forestry University and Yangzhou University.

Distribution. China (Guangxi, Hong Kong).

Host plants. *Millettia pachycarpa*, *Cinnamomum camphora*.

Remarks. It is similar to *P. cinnamomi* Takahashi by shape, but differs in the puparium being a little narrower and the transverse molting suture not reaching the margin. It also resembles *P. yasumatsui* Takahashi, but can be easily distinguished by color.

4. ***Pentaleyrodes yasumatsui* Takahashi** (Figs. 7–10), new record to China

Pentaleyrodes yasumatsui Takahashi, 1939. *Kontyû*, 13: 76; Suh 2009. *Journal of Asia-Pacific Entomology*, 12: 47.

Diagnosis. Puparia: black; brown after slide-mounted, elliptical, a little sclerotized, flattened, about 0.91–1.25 mm in length, 0.64–0.95 mm in width. Slightly waxy palisade present along the margin which is 22.7 μm in length. Margin surrounded by a waxy palisade and fringe. Marginal teeth distinct, arranged in 2 rows, outer teeth much wider than long, rounded, about 7 crenulations in 0.1 mm; inner teeth hemispherical. Anterior and posterior marginal setae absent.

Dorsum. Very narrowly pale on the margin, with 2 pairs of pale patches on the cephalothorax and a pair of longitudinal pale stripes on the abdomen. Dorsum distinctly reticulate except the median area, lacking ridges and granules, with many very small circular translucent pores scattered except on the narrow marginal area. Submarginal area not clear, not separated from the dorsal disk, 16 pairs of long setae arranged in a row along the margin, which are subequal in length, about 127.6 μm long, each arising from a small tubercle. Longitudinal molting suture reaching the margin and transverse molting suture reaching the submargin.

Thoracic and abdominal segment sutures well defined, abdominal I–VI subequal in length, about 45.2 μm; abdominal VII and VIII about 27.6 μm. A pair of depressions present at the median of each thoracic and abdominal segment suture. Cephalic and 1st abdominal setae absent, 8th abdominal setae present. Thoracic tracheal folds and pores absent.

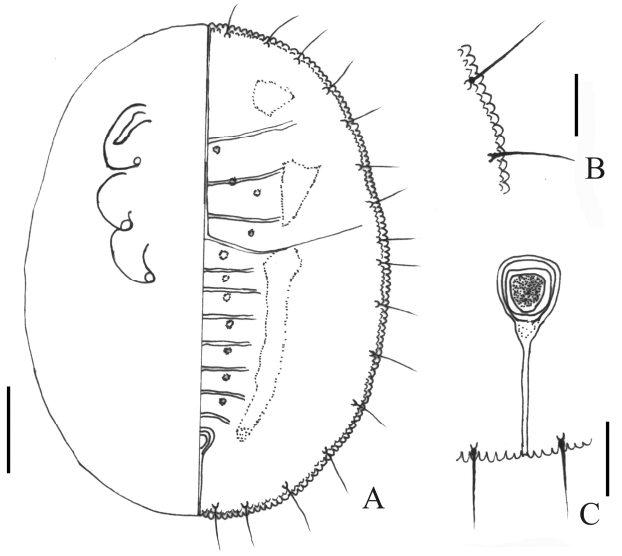


Figure 8. *Pentaleyrodes yasumatsui* Takahashi. A. Puparium; B. Margin and submarginal setae; C. Vasiform orifice and caudal furrow. Scale bars = 0.2 mm (A); 0.05 mm (B); 0.04 mm (C).

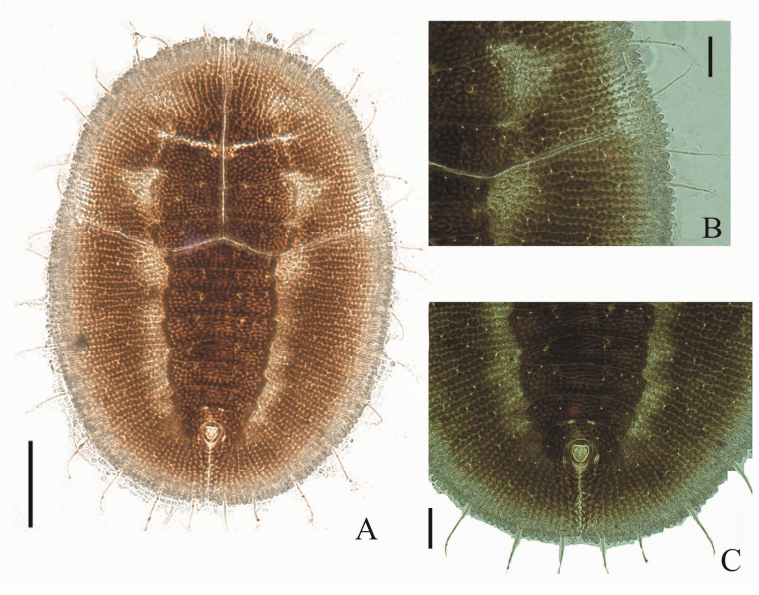


Figure 9. *Pentaleyrodes yasumatsui* Takahashi, slide mounted specimen. A. Puparium; B. Margin and submarginal setae; C. Vasiform orifice and caudal furrow. Scale bars = 0.2 mm (A); 0.05 mm (B); 0.05 mm (C).

Vasiform Orifice. vasiform orifice cordate, nearly as long as wide, thickened on the margin, not notched at the hind end, 44.7 μm in length, 47.1 μm in width. Operculum subcordate, 27.2 μm long, 26.8 μm wide, almost covering all the orifice. Lingula not exposed. Caudal furrow distinct, very narrow, expanded at the base, about 110.2 μm long.

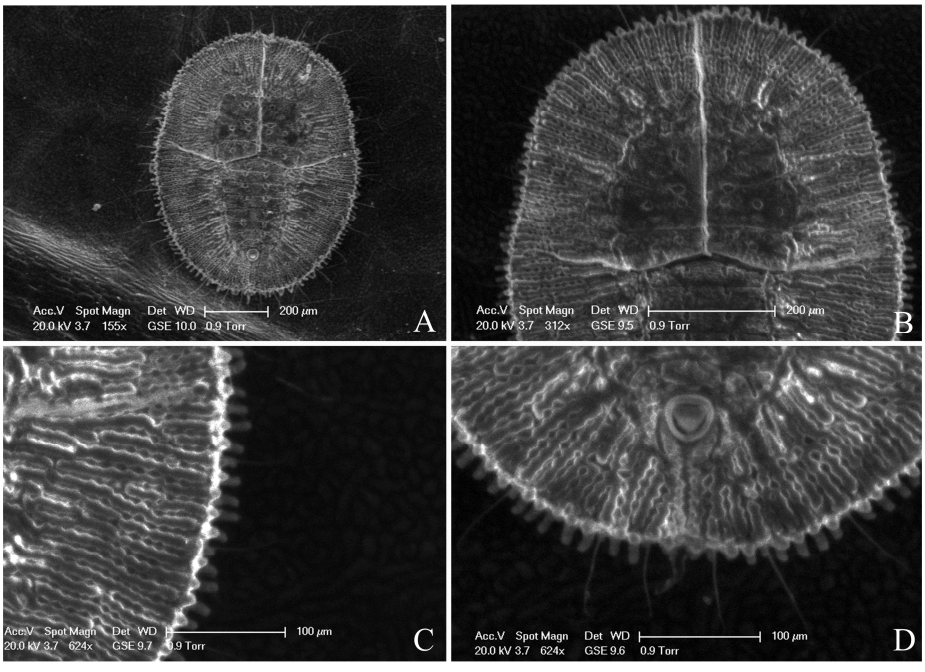


Figure 10. SEM of *Pentaleyrodes yasumatsui* Takahashi. A. Puparium; B. Moulting suture; C. Margin and submarginal setae; D. Vasiform orifice and caudal furrow.

Specimens examined. 20 puparia on 16 slides, on *Machilus thunbergii*, **China,** Hangzhou, Xijingshan Mt., 26-III-2015, Coll. Jirui WANG, deposited in Insect Collection of Zhejiang Agriculture & Forestry University; 15 puparia on 13 slides, on *Cinnamomum camphora*, **China,** Dayaoshan Mt., 24-VII-2015, Coll. Jirui WANG, deposited in Insect Collection of Zhejiang Agriculture & Forestry University and Yangzhou University.

Distribution. China (Zhejiang, Guangxi); Japan; Korea.

Host plants. Lauraceae: *Machilus thunbergii*, *Lindera* sp., *Litsea glauca.*

Remarks. This species was first described by Takahashi (1939). It is similar to *P. hongkongensis* Takahashi by the shape, the presence of patch and stripes on the cephalothorax and abdomen, but can be distinguished by the color. *P. yasumatsui* is black while *P. hongkongensis* is pale white.

Key to the puparia of *Pentaleyrodes* species from China

1. Cephalic and 1st abdominal setae present ····· 2
-. Cephalic and 1st abdominal setae absent ····· 3
2. With 3 large black patches on the median area·····*P. cinnamomi* Takahashi
-. Without 3 large black patches on the median area; slightly constricted on cephalothorax ·····
·····*P. linderae* Chou & Yan

3. Puparia pale white, the marginal teeth small, the dorsal reticulations not distinct, the longer space between the vasiform orifice and hind end ····· *P. hongkongensis* Takahashi
-. Puparia black, the marginal teeth larger, the dorsal reticulations distinct, the shorter space between the vasiform orifice and hind end ····· *P. yasumatsui* Takahashi

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References

Bink-Moenen RM. 1983. Revision of the African whiteflies (Aleyrodidae). *Monografieën van de Nederlandse Entomologische Vereniging. Amsterdam*, 10: 1–211.

Chou I & Yan FM. 1988. New species and new records of Aleyrodidae (Homoptera) from China. *Entomotaxonomia*, 10: 243–246.

Evans GA. 2008. The whiteflies (Hemiptera: Aleyrodidae) of the world and their host plants and natural enemies. Available from: http://keys.lucidcentral.org/keys/v3/whitefly/PDF_PwP%20ETC/world-whitefly-catalog-Evans.pdf (Version 070606) (Accessed 23 January 2016).

Gill R. 1990. The morphology of whiteflies. *In*: Gerling D (Ed.), *Whiteflies: Their Bionomics, Pest Status, and Management*. Intercept Ltd, Andover, pp. 13–46.

Lin GK. 1961. *An original record of the investigation of the Aleyrodidae insects in Kiangxi province*. Agriculture Department of Kiangxi Province, 25 pp.

Martin JH. 1985. The whitefly of New Guinea. *Bulletin of the British Museum* (*Natural History*) (*Entomology*), 50(3): 303–351.

Martin JH. 1987. An identification guide to common whitefly pest species of the world (Homoptera: Aleyrodidae). *Tropical Pest Management*, 33: 298–322.

Martin JH & Mound LA. 2007. An annotated check list of the world's whiteflies (Insecta: Hemiptera: Aleyrodidae). *Zootaxa*, 1492: 1–84.

Suh SJ. 2009. New records of Korean whiteflies (Hemiptera: Aleyrodidae). *Journal of Asia-Pacific Entomology*, 12(1): 45–49.

Takahashi R. 1932. Aleyrodidae of Formosa, Part I. *Report. Department of Agriculture. Government Research Institute. Formosa*, 59: 1–57.

Takahashi R. 1937. Notes on the Aleyrodidae of Japan (Homoptera) V. *Kontyû*, 11: 310–311.

Takahashi R. 1939. Notes on the Aleyrodidae of Japan (Homoptera) VII. *Kontyû*, 13: 76–81.

Takahashi R. 1941. Some foreign Aleyrodidae (Homoptera) IV. Species from Hong Kong. *Transactions of the Natural History Society of Formosa*, 31: 388–393.

Wang JR, Dubey AK & Du YZ. 2013. Description of a new species of *Tuberaleyrodes* (Hemiptera: Aleyrodidae) from China. *Florida Entomologist*, 96(2): 619–623.

Wang JR, Dubey AK & Du YZ. 2014. Description of a new species of *Aleuroclava* Singh (Hemiptera: Aleyrodidae) from China. *Florida Entomologist*, 97(2): 685–691.